MACROHABITAT COMPOSITION SURROUNDING SUCCESSFUL AND DEPREDATED NORTHERN BOBWHITE NESTS

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ABSTRACT

Relationships among macrohabitat and depredation of northern bobwhite (*Colinus virginianus*) nests are poorly understood. Yet, macrohabitat composition may influence the nest predator community and, therefore, the vulnerability of northern bobwhite nests to depredation. We determined if macrohabitat composition surrounding bobwhite nests influenced nest placement, nest success, and which predators were responsible for depredating nests. We characterized macrohabitats at 2 scales, 8 and 16 ha, by surrounding both bobwhite nests, and an equal number of random locations, with a circular buffer. Random points were placed within the area used by bobwhites on our study area. We then determined the acreage of each macrohabitat category within each circular buffer to determine the macrohabitat composition. Macrohabitat categories included hardwood forested drains, upland pine forests burned in March of the same calendar year, upland pine forests burned in March of the previous calendar year, and fields. We documented nest predators using infrared video cameras placed at the nest site. We monitored 104 bobwhite nests on Tall Timbers Research Station (TTRS) during 1999 and 2000. Size of the circular buffer around nests did not qualitatively affect results. Area (ha) of upland pine forests and fields were similar at depredated nests, hatched nests, and random locations. However, there was an average of 81% and 56% more area of hardwood drain in the circular buffers associated with random locations than at successful and depredated nests, respectively. Area of upland pine forests and fields were similar for nests depredated by raccoon (*Procyon lotor*), armadillo (*Dasypus novemcinctus*) and snake (*Elaphus* spp.). However, there was an average of 6.1 and 3.3 times more area of hardwood drain surrounding nests that were depredated by snakes relative to nests depredated by raccoons and armadillos, respectively. While our sample sizes were low, bobwhites exhibited a tendency to place nests in landscapes with less hardwood drain than were generally available on the study area. Macrohabitat surrounding nests influenced the type of nest predator to depredate nests. To minimize depredation of bobwhite nests by snakes, we suggest nesting cover should be developed away from drain edges.

INTRODUCTION

Since the 1960s bobwhite populations in the Southeast have declined by 70% (Brennan 1991, Church et al. 1993). Year-round habitat needs of bobwhites have been well documented (Brennan 1999). However, bobwhite-nest predator interactions and the effects of nesting macrohabitat composition on the vulnerability of nest location to depredation needs further research (Rollins and Carroll 2001).

Nest depredation may limit bobwhite densities (Errington and Stoddard 1938) as in other game birds (Newton 1998:247). In many bird species, depredation is the major cause of egg and chick losses, commonly accounting for around half of all nesting attempts and more than 80% of all nest failures (Nice 1937, Lack 1954, Ricklefs 1969, Martin 1991). The effect of ma-

crohabitat composition on nest vulnerability and depredation rates is poorly understood. Yet, suitability of a nest site for bobwhites may depend on macrohabitat composition. Despite years of locating bobwhite nests using telemetry, identification of nest predators at depredated nests has been problematic and likely inaccurate (Fies and Puckett 1999, Larviere 1999, Pietz and Granfors 2000). With the advent of infrared, continuous video cameras, accurate identification of predators is now possible (Staller 2001).

Using this new technology, we compared macrohabitat composition surrounding nest sites to determine if certain macrohabitats predisposed nests to depredation by different nest predators. We also compared macrohabitats surrounding bobwhite nests to random locations to assess if bobwhites were selecting for particular macrohabitats on our study area. We hoped that this information would provide ideas for reducing nest depredation through habitat management.

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METHODS

Study Site

Tall Timbers Research Station is located in the Red Hills region of the Gulf Coastal Plain in Florida and Georgia. Tall Timbers Research Station is approximately 1,568 ha in size, and is dominated by short leaf (*Pinus echinata*) and loblolly pine (*P. taeda*). Intermixed throughout the study site are narrow hardwood drains and large hammocks (27.5% of the area). Fields (7.9% of area), 0.4–1.2 ha in size, are maintained with annual disking. Early fall bobwhite densities, based on fall covey call counts, were about 1.8 and 2.2 birds/ha, during 1999 and 2000, respectively. Management for TTRS consists of prescribed burning, mowing, roller chopping, and disking. Mammalian predators have not been removed since 1990.

Camera System Design

The video camera system consisted of a model N9C2 Fieldcam™ LRTV Microcam™ with a 3.7 mm wide-angle lens and a 6 array LED at 950 nm (Furman Diversified Inc. 2912 Bayport Blvd. Seabrook, TX 77586). Natural sunlight, as well as an auxiliary 36-array LED infrared illumination system at 950 nm, provided light for 24-hour surveillance. The Fieldcam™ and illumination system was supported on a camouflaged articulating arm clamped to a wooden stake, and was connected to a VHS time-lapse video recorder that recorded 20 fields per second. A Tote™ LCD 410 field and setup monitor allowed technicians to view the nest while setting up the system. A 225-reserve capacity Marine Source™ deep cycle battery powered the entire system.

Data Collection

Land cover maps were created from aerial imagery and GPS using Arc View. Macrohabitat categories included pine forests burned in March of the same calendar year (hereafter, burned pine), pine forests burned in March of the previous calendar year (hereafter, unburned pine), hardwood forested drains (hereafter, drain), fields, roads, wetlands, and manicured areas. Edges of drains were mapped using GPS.

Approximately 100 bobwhites were captured January–April, 1999–2000, on an 1,100 ha area of TTRS using "walk in" funnel-traps (Smith et al. 1981), baited with cracked corn. We classified bobwhites by sex and age, banded, and weighed them, and released them at the capture site. Trapping, handling and marking procedures were consistent with the guidelines in the American Ornithologists' Union Report of Committee on Use of Wild Birds in Research (American Ornithologists' Union 1988), and those of the University of Georgia, Institutional Animal Care and Use Committee, permit # A34337-01. A sample of birds ≥150g were fitted with 6.4–6.9 g necklace radio transmitters (American Wildlife Enterprises, 493 Beaver Lake Rd. Tallahassee, FL 32312).

To locate nests, bobwhites were located daily using telemetry homing techniques (White and Garrott 1990). Telemetry equipment consisted of a 3-element, directional, hand-held, yagi antenna and portable receivers. When nests were located, we plotted the location on a land cover map, and monitored nest fates using 6 and 13 infrared surveillance cameras in 1999 and 2000 field seasons, respectively.

Cameras were set approximately 1.5 m from bobwhite nests when the incubating adult was away from the nest. We attempted to minimize modifying vegetation near the nest location. Thirty meters of cable connected the camera to the VHS-recording unit. All cables were laid flat on the ground and did not cross a likely predator travel route (e.g., firebreak, field edge, or road). The camera arm, lens, and recording unit were completely camouflaged in order to conceal the equipment. During the 2000 field season, we checked the incubating bobwhite every 1–2 hours after placing the camera at the nest site. If the bobwhite was in the near vicinity, but had not resumed incubation within 4–6 hours the camera was moved farther from the nest and set at an angle to the entrance to minimize disturbance to the incubating bobwhite. Every 24-hours a technician retrieved the previous day's tape, and replaced the battery. The last 2 minutes of the VHS-tapes were viewed daily to ensure the camera had not been moved by weather or animal contact. All tapes were ultimately reviewed to gather pertinent data.

Data Analysis

Nests were categorized as hatched or depredated. We did not include nests that were depredated by ≥1 predator in our analysis. We also limited our comparisons to nests depredated by raccoons, armadillos, and snakes because of small sample sizes associated with the other depredating species.

Random locations were generated in Arc View using a random points theme that placed the points on the study area map. Nest locations were digitized onto our study area map. Habitat categories included in the analysis were burned and unburned pines, drains, and fields.

At random and nest locations, we added 8-ha and 16-ha circular buffers. Buffer size was based on the home ranges of bobwhites at our study site. Macrohabitat categories and macrohabitat compositions were determined using a clip polygon theme in Arc View. Mean area (ha) and 95% confidence intervals of each macrohabitat category were calculated for each nest and random location. Due to low sample sizes, we presented area means and an approximate 95% confidence intervals (2*SE) in graphical format rather than applying parametric statistics.

RESULTS

We monitored the outcome of 30 bobwhite nests on TTRS during 1999. The 30 events consisted of: 10 hatches (33.3%), 14 depredations (46.7%), and 6 nest abandonments (20%). The 14 depredations consisted of 12 documented depredations and 2 unrecorded depredations due to camera failure.
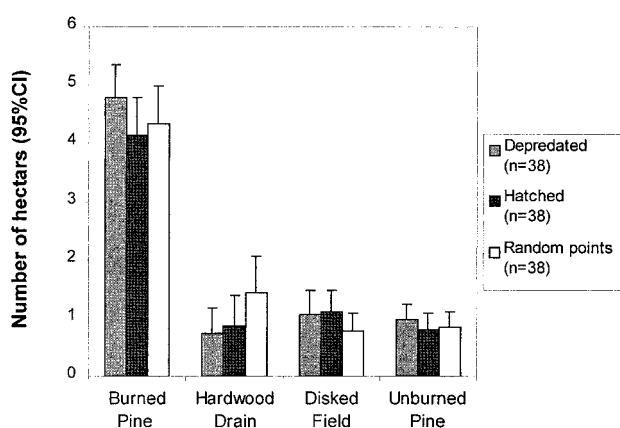
Fig. 1. Mean hectares and 95% CI for 8-ha areas around depredated bobwhite nests, hatched bobwhite nests, and random points on Tall Timbers Research Station, Leon County, Florida during 1999 and 2000.

Fig. 3. Mean hectares and 95% CI for 8-ha areas around raccoon, armadillo, and snake depredated bobwhite nests on Tall Timbers Research Station, Leon County, Florida during 1999 and 2000.

During 2000, we monitored the outcome of 74 bobwhite nests at TTRS. We documented 74 events, including 41 hatches (55.4%), 31 depredations (41.9%), and 2 nest abandonments (2.7%).

Predator Identification

Individual predators were identified to species (mammals) or genus (snakes) on 58 occasions at 45 depredated nests during the 1999-00 field seasons. Thirty-eight of the 45 depredated nests were depredated by one predator, including; 15 rat snake, 13 raccoon, and 10 armadillo depredations. These 38 depredations were used to compare macrohabitat composition.

Habitat Characteristics

There was no qualitative difference between macrohabitat compositions of areas surrounding nests at the 8-ha and 16-ha scales. Therefore, results for each buffer size were averaged for presentation in text. At the 8-ha and 16-ha scales, proportions of burned pine, unburned pine, and fields were similar for depredated nests, hatched nests, and for random locations (Figs.
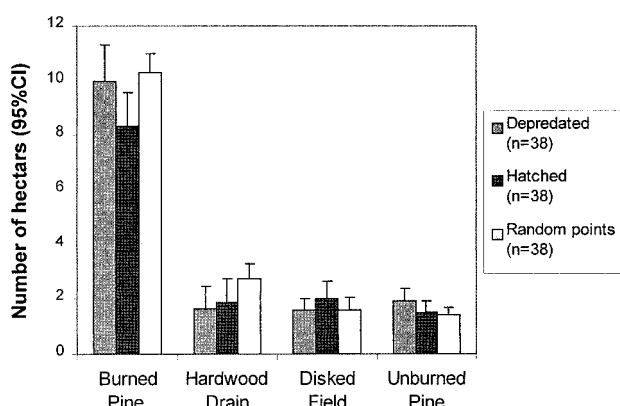
1, 2). However, random locations had an average of 81% and 56% more drain than hatched and depredated nests, respectively.

At the 8-ha and 16-ha scales, areas of burned pine, unburned pine, and fields were similar for bobwhite nests depredated by raccoons and armadillos, although nests depredated by snakes were surrounded by slightly less area of burned pine (Figs. 3, 4). Nests depredated by snakes were surrounded by 6.1 and 3.3 times more area of drain compared to nests depredated by raccoons and armadillos, respectively. Relative to amount of drain surrounding all nests, nests depredated by raccoons, armadillos and snakes were surrounded by 0.3, 0.5, and 1.6 times the amount of drain, respectively. Relative to the amount of drain surrounding random locations, nests depredated by raccoons, armadillos, and snakes were surrounded by 0.2, 0.3, and 1.0 times the amount of drain, respectively.

DISCUSSION

While our sample size was low, our data suggest that bobwhites selected nesting landscapes with less

Fig. 2. Mean hectares and 95% CI for 16-ha areas around depredated bobwhite nests, hatched bobwhite nests, and random points on Tall Timbers Research Station, Leon County, Florida during 1999 and 2000.
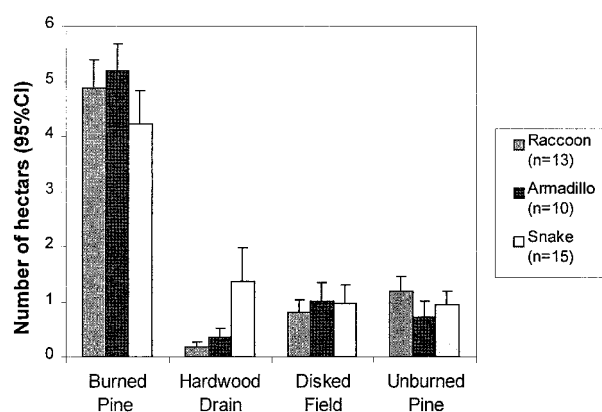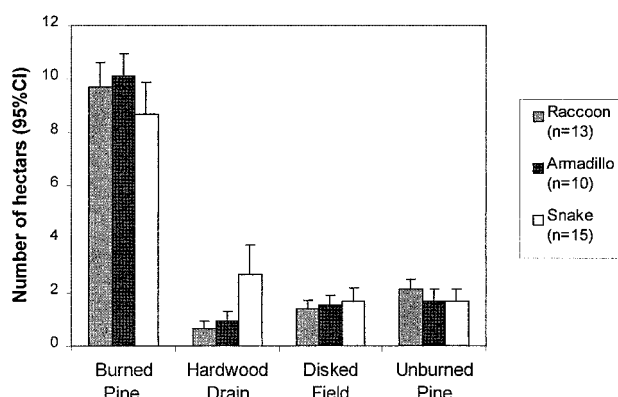

Fig. 4. Mean hectares and 95% CI for 16-ha areas around raccoon, armadillo, and snake depredated bobwhite nests on Tall Timbers Research Station, Leon County, Florida during 1999 and 2000.

drain than generally available on the study area. Although not suspected to be the case, our data may be biased if a greater proportion of nests located near or in drains were depredated during the laying period than nests located in upland sites. This is because incubation of a nest by a radiomarked bobwhite was necessary for us to find nests. Therefore, the apparent distribution of nests on TTRS may have been a function of depredation and macrohabitat composition, rather than the latter alone.

Differences in macrohabitat composition among hatched and depredated nests, and all nests and random locations, were minor. This suggests bobwhites on TTRS were not selecting nesting areas based on specific macrohabitat compositions, but were selecting nesting areas in proportion to the available macrohabitat categories. Microhabitat composition of the ground story likely predominates in the selection of a nest site by a bobwhite (Taylor et al. 1999). On TTRS, suitable ground cover vegetation for bobwhite nesting existed regardless of the macrohabitat composition. Another reason for the minor differences found between macrohabitat composition from nest and random locations was because random locations were based on sampled bobwhite nests, second order selection had likely already occurred (Johnson 1980).

Lack of differences between macrohabitat composition of depredated and hatched nests suggests that, overall, success of a nest was not greatly influenced by macrohabitat composition. This is reasonable, given that the nest predators in our study area have relatively generalist habitat needs and diets. One exception to the lack of differences in macrohabitat composition between nests was the apparent differences between macrohabitat composition surrounding nests depredated by snakes versus armadillos and raccoons. Nests depredated by snakes had more drain than other predators and all nest sites. This suggests that gray rat snakes were either more successful at finding bobwhite nests associated with drains, or that mammals foraged more in the upland pine forests and gray rat snakes foraged more in upland pine forests near drains. In Mississippi, Burger and Richardson (1999) found that gray rat snakes preferred upland hardwood patches in an upland pine matrix, which supports the idea that on TTRS gray rat snakes foraged near drains. From 1997–1999, most invasive hardwoods were removed from upland pine areas, suggesting that TTRS may have reduced the rat snake habitat in the uplands, and hence they were associated more with hardwoods in drains.

CONCLUSION

Our results are preliminary, however we suggest managers create nesting habitat away from hardwood drains running through upland pine forests. On our study area, this would be possible by maintaining more of an annual forb community along drains by annual burning, rather than burning on a 2 or 3 year cycle (Taylor et al. 1999). Reduction of hardwood pockets in upland pine forests may also reduce nest depreda-

tions by snakes. However, given the complexities of predator interactions with bobwhites, larger sample sizes and macrohabitat composition on other nest predator species is needed to provide reasoned habitat management recommendations to reduce nest depredation.

ACKNOWLEDGMENT

LITERATURE CITED

American Ornithologists' Union. 1988. Report of committee on use of wild birds in research. Auk 105 (Supplemental 1:1–41).

Brennan L. A. 1991. How can we reverse the northern Bobwhite population decline? Wildlife Society Bulletin 19:544–555.

Brennan L. A. 1999. Northern bobwhite *Colinus virginianus.* The Birds of North America, No. 397, A. Poole and F. Gill, eds. The Academy of Natural Sciences, Wasington D. C., and the American Ornithologists' Union, Philadelphia, Pennsylvania.

Burger, L. W., and D. Richardson. 1999. Spatial ecology of gray rat snakes in red-cockaded woodpecker clusters in east-central Mississippi. Final project report, Project number E-1, Segment 12, Mississippi Department of Wildlife, Fisheries and Parks, Starkville.

Church, K. E., J. R. Sauer, and S. Droge. 1993. Population trends of quail in North America. Proceedings of the National Quail Symposium 3:44–64.

Errington, P. L., and H. L. Stoddard. 1938. Modifications in predation theory suggested by ecological studies of the bobwhite quail. Transactions of the North American Wildlife Conference 3:736–740.

Fies, M. L., and K. M. Puckett. 1999. Depredation patterns of northern bobwhite nest predators in Virginia. Proceedings of the National Quail Symposium 4:96–102.

Johnson, D. H. 1980. The comparison of usage and availability measurements for evaluating resource preference. Ecology 61:65–71.

Lack, D. 1954. The natural regulation of animal numbers. Oxford University Press, Oxford, United Kingdom.

Lariviere, S. 1999. Reasons why predators cannot be inferred from nest remains. Condor 101:718–721.

Martin, T. E. 1991. Food limitation in terrestrial breedingbird populations: is that all there is? Proceedings of the International Ornithology Congress 20:1595–1602.

Newton, I. 1998. Population limitation in birds. Academic Press Limited, San Diego, California.

Nice, M. M. 1937. Studies in the life history of the song sparrow. Part 1. Transactions of the Linnean Society 4:1–247.

Pietz, P. J., and D. A. Granfors. 2000. Identifying predators and fates of grassland passerine nests using miniature video cameras. Journal of Wildlife Management 64:71–87.

Ricklefs R. E. 1969. An analysis of nestling mortality in birds. Smithsonian Contributions of Zoology 9:1–48.

Rollins, D., and J. P. Carroll. 2001. Impacts of predation on northern bobwhite and scaled quail. Wildlife Society Bulletin 29:33–38.

Smith, H. D., F. A. Stormer, and R. D. Godfrey, Jr. 1981. A collapsible quail trap. Research Note RM-400. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Staller, E. L. 2001. Identifying predators and nest fates of northern bobwhite nests using miniature video cameras. Thesis. University of Georgia, Athens.

Taylor, J. S., K. E. Church, and D. H. Rusch. 1999. Microhabitat selection by nesting and brood-rearing northern bobwhite in Kansas. Journal of Wildlife Management 63:686–694.

White, C. G. and R. A. Garrott. 1990. Analysis of radio-tracking data. Academic Press, San Diego, California.